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Abstract

All Holstein herds of over 20 cows which had automated data processed dairy herd improvement association (DHIA) records from Cornell laboratory for two consecutive years from 1960 to 1964 were used to determine production, feeding, and management changes. The average number of herds for the four 2-yr comparisons was 2,688, 60% in New York and the remainder in neighboring states. Results in the two locations agreed. The yearly changes and standard deviations of changes per cow for the New York herds were milk production, + 157 ± 400 kg; grain feeding, + 88 ± 241 kg; succulent forage, + 0.13 ± 1.76 metric ton; dry forage, − 0.04 ± 0.50 metric ton; net energy from pasture, − 0.60 ± 6.10%; herd size, + 1.8 ± 5.65 cows; days in milk, + 0.24 ± 2.93%. Only two factors were closely correlated with change in milk production — change in grain fed and change in per cent days in milk. Multiple regression analysis, using the six factors above, indicated that a change of 1 kg in grain feeding resulted in a change of 0.84 kg of milk and a 1% change in days in milk gave a change of 45 kg of milk.

The objective of this study was to determine the relationship of changes in DHIA production and changes in feeding, particularly the amounts of concentrates and forages fed. For the past several years there has been increased emphasis on feeding more grain to lactating cows. Excellent reviews (2, 4-6) have indicated a favorable but variable response to more liberal grain feeding.

One of the earlier, extensive input-output studies, that of Jensen et al. (3) with only moderate levels of production, found that at the lowest level of concentrate feeding one additional kilogram of concentrate resulted in a 1.7 kg increase in FCM, whereas at the highest level only a 0.6 kg increase resulted. These same trends have, in general, been reported by the more recent work with higher producing cows and higher levels of feeding. A major reason explaining why the requirement is increased at high levels of feed intake has been reported by Reid et al. (7) and supported by Brown (1). Their explanation is that, as the level of feeding increases, the digestibility of the diet decreases. The point of optimum level of grain feeding is where the last increment of grain fed still makes a profit in terms of milk production.

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Experimental Procedure

Data for this study included all Holstein herds of 20 or more cows having automated data processing of their records for two or more consecutive years during the five test years ending April, 1960, to April, 1964. New York herds and out-of-state (O.O.S.) herds processed in the Cornell laboratory were analyzed separately. As shown in Table 1, the number of New York herds ranged from 890 to 2,133 and the number of O.O.S. herds from 669 to 1,482.

A second phase of this study was to examine the year-after-year changes that dairymen make in grain feeding or in milk production. This analysis used data from all herds on test all five of the years. The herds were grouped according to the changes they made during the initial year; then the changes made in each subsequent year were calculated.

Results and Discussion

Table 1 shows the number of herds, average production, and feed intakes for each comparison of two consecutive years. Average changes made from one year to the next are given in Table 2. The change in milk production from Table 2 for 1960 to 1961, when added to the average production given in Table 1 for 1960, does not give the average production for 1961 in Table 1. The same is true of the other factors. For example, the 890 New York herds produced 5,330 kg of milk in 1960 (Table 1). They increased their production 147 kg (Table 2) so that their production in 1961 was 5,477 kg. For the 1961-1962 comparison there were 1,377 herds which started out with an average pro-

TABLE 1

Average production, feed inputs, herd size, and days in milk

	Test year ending April							
	1960 [a]		1961		1962		1963	
	N.Y.	O.O.S.[b]	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.
Herds (No.)	890	669	1,377	1,054	1,809	1,337	2,133	1,482
Actual milk (kg)	5,330	5,062	5,448	5,135	5,588	5,343	5,802	5,479
Actual fat (kg)	193	191	198	194	203	202	209	207
Concentrate (kg)	1,554	1,641	1,655	1,711	1,743	1,853	1.907	1,990
Succulent forage (m.t.)	4.8	4.4	4.7	4.5	4.7	4.5	5.0	4.8
Dry forage (m.t.)	2.1	1.8	2.1	1.8	2.1	1.8	2.0	1.7
Pasture (% net energy)	16	19	16	18	16	18	13	16
Cow years (No.)	44.2	44.1	44.7	45.3	46.0	46.9	46.7	47.7
Day in milk (%)	83	83	84	84	84	84	84	84

[a] Herds were on test two consecutive years. During the first year their production, etc., was as shown in the table.

[b] O.O.S. = Out of state, but processed at the Cornell laboratory.

TABLE 2

Year-to-year changes

	1960 to 1961		1961 to 1962		1962 to 1963		1963 to 1964		Mean	
Changes per cow	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.
Milk (kg)	147	76	154	200	232	176	98	120	157	143
Concentrates (kg)	102	64	82	136	164	153	−4	215	88	142
Succulent forage (m.t.)	0.13	0.11	0.15	0.21	0.32	0.34	−0.07	0.18	0.13	0.21
Dry forage (m.t.)	−0.05	0.04	−0.04	−0.02	−0.05	−0.08	−0.01	−0.04	−0.04	−0.03
Pasture (% net energy)	−0.33	−0.57	−0.23	−0.75	−3.02	−2.45	1.18	−0.55	−0.60	−1.08
Cow years (No.)	2.3	2.1	2.2	1.9	1.2	1.3	1.4	1.5	1.8	1.7
Days in milk (%)	0.47	0.29	0.37	0.51	−0.22	−0.31	0.32	0.35	0.24	0.21

duction of 5,448 kg. Thus, the population of herds changes due to membership turnover and an increase in total membership participation. For New York, 688 of the 890 original herds remained on test the second year and 689 new herds were enrolled.

Table 2 shows that the trend has been increased production per cow and feeding more concentrate and succulent feeds but less dry forage and less pasture. There also has been an increase in herd size and a slight increase in per cent days in milk. During the growing season of 1962 (coincides to test year ending April, 1963) New York experienced a severe drought in many areas. Consequently, much less pasture was available and somewhat less dry forage. To compensate, more purchased concentrate was fed and, as a result, substantial increases in milk production resulted. In the following year changes were made towards a more typical feeding situation for New York.

Standard deviations of the mean changes are given in Table 3. That these standard deviations are large indicates that herds have con-

TABLE 3

Standard deviations of mean changes

	1960 to 1961		1961 to 1962		1962 to 1963		1963 to 1964		Mean	
Change in	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.
Milk (kg)	406	375	384	391	405	403	406	398	400	392
Concentrate (kg)	219	228	227	241	272	264	247	271	241	251
Succulent forage (m.t.)	1.76	1.58	1.83	1.66	1.81	1.77	1.62	1.72	1.76	1.69
Dry forage (m.t.)	0.50	0.47	0.48	0.48	0.52	0.51	0.48	0.49	0.50	0.49
Pasture (% net energy)	6.27	5.94	6.54	6.19	6.19	5.99	5.40	5.66	6.10	5.94
Cow years (No.)	5.10	5.37	5.38	5.11	6.73	5.18	5.39	5.70	5.65	5.34
Days in milk (%)	2.72	3.14	3.26	3.88	3.02	3.08	2.72	2.66	2.93	3.19

TABLE 4

Simple correlations of change in milk with various factors

Change in milk and change in	1960 to 1961		1961 to 1962		1962 to 1963		1963 to 1964		Mean	
	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.
Concentrate	0.54	0.46	0.52	0.51	0.51	0.51	0.53	0.49	0.53	0.49
Succulent forage	−0.01	−0.05	0.05	−0.04	−0.01	0.01	0.01	0.04	0.01	−0.01
Dry forage	0.00	0.04	−0.04	0.02	0.05	0.04	0.01	−0.06	0.01	0.01
Pasture	−0.03	−0.05	−0.07	−0.06	−0.11	−0.10	−0.07	−0.06	−0.07	−0.07
Cow years	−0.19	−0.18	−0.16	−0.16	−0.11	−0.12	−0.19	−0.10	−0.16	−0.14
Per cent days in milk	0.43	0.44	0.33	0.34	0.40	0.45	0.47	0.48	0.41	0.43

siderable variation in their year-to-year changes.

Simple correlation (Table 4) and multiple regression analyses (Table 5) were made to determine the effect of changes in feeding on milk production. Only linear terms were used in the multiple regression. The analyses for any pair of years were applied to data for all DHIA herds having herd average values for both years. However, results may have differed somewhat between those herds which began testing in the first year and those on test for some time. This problem was not investigated. Table 4 indicates that changes in milk production are fairly closely associated with changes in succulent or dry forage fed, and are very slightly negatively correlated with change in pasture and size of herd.

The multiple regression coefficients in Table 5 indicate the predicted change in milk production for a change of one unit of each variable. For example, for New York the best prediction would be that an increase of 1 kg of concentrate would result in 0.84 kg more milk if succulent forage and other factors studied were held constant. In actual situations, of course, it is probably never true that one variable is changed while all others remain constant. Still, as a prediction of the contribution of change in concentrate feeding, independent of other factors, the above figure is the best one for these data, considering only a linear model.

The fact that the ratio of milk production change to concentrate change is less than 1 to 1 has several implications. Some dairymen, either intentionally or unintentionally, are not feeding grain precisely according to the needs of the individual cow. Secondly, a few dairymen have a very favorable market, which allows for liberal feeding of grain to obtain maximum milk production. Thirdly, the use of Government CCC corn and other concentrates to replace a proportion of the forage in drought years would tend to result in a ratio such as the one obtained.

Of the variables studied, when the size of the unit change is considered, only two factors are of any real significance—concentrates fed and per cent days in milk. In fact, R^2, which measures the per cent of the total variation accounted for, is 0.39 when change in concentrate and change in per cent days in milk are considered, and 0.41 when all six of the factors are included (0.36 and 0.38, respectively, for the O.O.S. herds). Change in concentrate alone accounted for 28% of the variation of change in milk (24% for O.O.S. herds).

The second phase of this study used only those herds on test all five years from 1960 through 1964. They were grouped according to change in milk production per cow for the first year, so that changes in subsequent years could be studied. Changes of multiples of 227 kg of milk and 181 kg of concentrate were the bases of grouping. There were 688 New York herds. Results are shown in Tables 6 and 7. Even though the average change in one year

TABLE 5

Multiple regression coefficients for predicting milk change

Factors	1960 to 1961		1961 to 1962		1962 to 1963		1963 to 1964		Mean	
	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.	N.Y.	O.O.S.
Concentrates (kg)	0.92	0.72	0.86	0.80	0.72	0.71	0.84	0.68	0.84	0.73
Succulent forage (m.t.)	39	69	39	30	53	62	76	78	52	60
Dry forage (m.t.)	112	164	−31	78	180	183	222	108	121	133
Pasture (% net energy)	6	12	6	39	8	8	11	9	8	17
Cow year (unit)	−1	−1	−1	−1	−0.5	−0.5	−1	−1	−1	−1
Days in milk (%)	48	44	37	24	40	43	56	60	45	43

TABLE 6

Change in milk production over a five-year period (New York)

Group according to 1960 to 1961 change	1960 to 1961 change	No. of herds	Production 1960	1961 to 1962 change	1962 to 1963 change	1963 to 1964 change	Production 1964
(kg)			*(kg)*				
>907	1,189	20	4,773	−26	314	−139	6,112
680 to 906	775	31	5,046	59	143	65	6,089
454 to 679	556	93	5,152	53	200	105	6,066
227 to 453	338	148	5,244	171	196	75	6,024
0 to 226	119	170	5,416	141	253	100	6,028
0 to −226	−102	130	5,597	213	318	50	6,078
−227 to −453	−318	61	5,587	205	253	149	5,877
>−454	−619	35	5,685	325	357	108	5,855
Average	168	688	5,371	156	248	82	6,025

is relatively small, there was a substantial number of herds having relatively large changes. This is indicated by the standard deviation of the changes (Table 3). In general, the largest plus changes were made by the herds lowest in that factor at the time, and vice versa. In subsequent years there was a slight tendency to reverse the magnitude of the change, but by the third subsequent year there was no definite pattern of change. There was a definite tendency for herds to move toward the average.

Conclusions

Of the management factors measured in this study, change in concentrate feeding and per cent days in milk were the most important factors which change milk production.

For the New York herds, milk production increased 157 kg yearly and concentrate only 88 kg—a favorable ratio. However, when other factors were considered at the same time (multiple regression), only 0.84 kg of extra milk was obtained for each extra 1 kg of grain fed.

Results were similar for the two analyses—New York and O.O.S. herds.

Results of the statistical analyses were similar from one year to another.

The variation in the factors studied was large, even though the mean changes may or may not have been great.

Acknowledgment

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TABLE 7

Change in concentrates fed over a five-year period (New York)

Group according to 1960 to 1961 change	1960 to 1961 change	No. of herds	Concentrate fed 1960	1961 to 1962 change	1962 to 1963 change	1963 to 1964 change	Concentrate fed 1964
(kg)			*(kg)*				
>544	653	26	1,343	0	68	14	2,077
363 to 543	417	70	1,461	32	122	45	2,077
181 to 362	231	177	1,524	54	177	5	1,991
0 to 180	68	258	1,565	82	172	0	1,887
0 to −180	−100	124	1,588	122	200	18	1,828
−181 to −362	−277	24	1,774	177	236	−9	1,901
>−363	−558	9	1,873	150	159	73	1,696
Average	113	688	1,551	77	172	9	1,928

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